hereby given to charge any such deficiency to our Deposit Account No. 01-0268.

REMARKS

In the final Action dated June 13, 2002, claims 1, 2, 7-9, 20 and 21 were finally rejected under 35 U.S.C. §102(a) as being anticipated by Katsuma, Miyazawa and Vishnevsky '580. Claims 4 and 6 were rejected under 35 U.S.C. §103(a) as being unpatentable over Miyazawa, Vishnevsky '580 and Katsuma.

Applicants and applicants' counsel acknowledge with appreciation the allowance of claims 10-19 and 24-32 and the indication of allowable subject matter with respect to claims 3, 5 and 22. In order to expedite allowance of this application, applicants have amended claims 3, 5 and 22 by rewriting them in independent form to incorporate the subject matter of the base claim and any intervening claims. Independent claim 1 has been amended to incorporate the subject matter of dependent claim 8, which has been canceled without prejudice or admission. Marked-up versions of the amended claims are attached hereto.

In view of the foregoing amendments, applicants respectfully submit that amended claims 3, 5 and 22 are now in condition for allowance. As discussed below, applicants

further submit that claims 1, 2, 4, 6, 7 and 9 are also allowable over the prior art of record.

The present invention relates to an ultrasonic motor having improved vibration efficiency. As pointed out by applicants at pages 1-2 of the specification, a conventional ultrasonic motor utilizes an elastic member to resiliently bias a piezoelectric element against a moving member to efficiently transmit a drive power due to oscillation of the piezoelectric element to the movable member. The conventional ultrasonic motor relies upon the expansion-and-contraction and flexural vibration of the piezoelectric element to drive the movable member and uses signal lines to transmit drive signals from a circuit board to the piezoelectric element.

The conventional ultrasonic motor is typically installed on a circuit board by means of a support member which holds the piezoelectric element to the circuit board, and signal transmission extends between the circuit board and the piezoelectric element for applying a drive signal to the piezoelectric element.

As further noted by applicants, the use of the support member, the signal transmission wires and the elastic member results in a significant loss in expansion-and-contraction and flexural vibration of the piezoelectric element. Thus, the general structure of the conventional

ultrasonic motor lends to inefficient transmission of drive force from the piezoelectric element to the moving member and impairs the electric-to-mechanical energy conversion.

The present invention provides an ultrasonic motor with a reduced loss in the drive force produced by a piezoelectric element so that the drive force is efficiently transmitted to a moving member, and facilitates a size reduction and improvement in reliability by eliminating unnecessary components from the motor.

In accordance with one aspect of the present invention recited by amended independent claim 1, the ultrasonic motor comprises a movable member disposed to undergo movement in response to a drive force, a substrate having a conductor pattern for conveying a drive signal from a drive circuit, a piezoelectric vibrator provided on the substrate for undergoing oscillating movement in response to the drive signal so as to contact the movable member and thereby generate the drive force for driving the movable member, and a support member provided on the substrate for fixedly mechanically supporting the piezoelectric vibrator at a point corresponding to a node of vibration of the piezoelectric vibrator on the substrate and transmitting the drive signal from the conductor pattern to electrodes of the piezoelectric vibrator.

By the structure recited in claim 1, the support member serves the dual function of supporting the piezoelectric element at a node of vibration of the piezoelectric vibrator and transmitting the drive signal from the conductor pattern to the piezoelectric element. As a result, vibration loss is reduced.

The prior art of record fails to disclose this subject matter of independent claim 1.

The present invention recited by claim 1 overcomes the problems associated with the conventional ultrasonic motor by providing an ultrasonic motor in which a piezoelectric element directly contacts a movable member in response to oscillation thereof and drives the movable member. The device has a support member provided on a substrate for mechanically and fixedly supporting the piezoelectric vibrator at a point corresponding to a node of vibration of the piezoelectric vibrator. The support member transmits drive signals from a conductor pattern to electrodes of the piezoelectric vibrator so that no conductor wires extend from the substrate to connect the drive circuit to the piezoelectric vibrator. Thus, in addition to facilitating excellent transfer of vibration from the piezoelectric vibrator to the movable member, the claimed invention eliminates the need for separate conductor wires and a support member by providing a support

member capable of serving as a conductive path. According to the present invention, the support member not only supports the piezoelectric element on a substrate, but also has the ability to transmit a drive signal to the piezoelectric element so that no conductor wires are needed.

The support member is preferably formed of a resilient material or has a flexible portion so that it resiliently urges the piezoelectric element against the movable member, thereby eliminating the need for a separate elastic member to bias the piezoelectric element and movable member. Accordingly, the present invention makes it possible to substantially reduce the size of the ultrasonic motor and reduces the loss associated with the use of multiple components as described above.

Claim 1 is not anticipated or rendered obvious by Katsuma, Miyazawa or Vishnevsky '580. None of these references discloses an ultrasonic motor in which a piezoelectric element comes into contact with a movable member to drive the movable member as recited by independent claim 1. Nor do the cited references disclose or suggest a support member which fixedly supports a piezoelectric vibrator at a point corresponding to a node of vibration thereof.

Vishnevsky '580 discloses a piezoelectric motor having a stator 1 and a rotor 3. The stator 1 has a housing 7

and a piezoelectric oscillator 6 mounted to the housing 7. The piezoelectric oscillator 6 has a piezoelectric cell 9 with electrodes 13 and pushers 10, each pusher 10 having one end secured to one flat surface of the piezoelectric cell 9 so that a gap 14 is provided between the piezoelectric cell 9 and the pusher 10. The other end of each pusher 10 rests against the rotor 3. Vishnevsky '580 fails to disclose or suggest any supporting structure for the piezoelectric vibrating body Although Vishnevsky '580 discloses elastic members (or pushers 10) interposed between the piezoelectric cell 9 and the rotor to convert the vibratory movement of the piezoelectric cell 9 into rotary movement of the rotor 3, the reference does not address the manner in which the piezoelectric element is supported.

Miyazawa discloses structure similar to that of Vishnevsky '580. For example, in the ultrasonic motor illustrated in Fig. 7 of Miyazawa, a piezoelectric element 3-1 is formed on a bottom surface of a stator 2-1. A rotor 1-1 has projections 1a-1 extending therefrom. The projections 1a-1 are disposed on a top surface of the stator 2-1. The piezoelectric element 3-1 is formed on the bottom surface of the stator 2-1 and never contacts the rotor 1-1. Miyazawa does not disclose or suggest the supporting structure recited

by amended independent claim 1. Nor does the reference disclose or suggest a piezoelectric element provided on a substrate for undergoing oscillating movement in response to the drive signal so as to contact the movable member and thereby generate the drive force for driving the movable member as required by claim 1.

The ultrasonic motor of Katsuma is similar to that of Vishnevsky '580 and Miyazawa and the reference does not disclose a piezoelectric element having the supporting structure required by amended independent claim 1.

Nor do the references disclose or suggest a substrate having a conductor pattern for conveying a drive signal from a drive circuit, a piezoelectric vibrator provided on the substrate, and a support member for supporting the piezoelectric vibrator and transmitting the drive signal to the piezoelectric vibrator as required by claim 1. Nothing in the cited references would have suggested this combination of elements.

Since Vishnevsky '580, Miyazawa and Katsuma fail to disclose or suggest the subject matter recited by independent claim 1, the claims are not anticipated or rendered obvious.

In view of the foregoing amendments and discussion, the application is now believed to be in condition for

allowance. Accordingly, favorable consideration and allowance of amended claim 1 and all other pending claims are most respectfully requested.

Respectfully submitted,

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MAILING CERTIFICATE

I hereby certify that this correspondence is being deposited with the United States Postal Service as first-class mail in an envelope addressed to: Commissioner of Patents & Trademarks, Washington, D.C. 20231, on the date indicated below:

PAUL HOFFMAN
Name

Signature

SEPTEMBER 13, 2002

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Claims 1, 3, 5 and 22 have been amended as follows:

1. (Five Times Amended) An ultrasonic motor, comprising: a movable member disposed to undergo movement in response to a drive force; a substrate having a conductor pattern for conveying a drive signal from a drive circuit; a piezoelectric vibrator provided on the substrate for undergoing oscillating movement in response to the drive signal so as to contact the movable member and generate the drive force to drive the movable member; and a support member provided on the substrate for mechanically fixedly supporting the piezoelectric vibrator at a point corresponding to a node of vibration of the piezoelectric vibrator on the substrate and transmitting the drive signal from the conductor pattern to electrodes of the piezoelectric vibrator so that no conductor wires extend from the substrate to connect the drive circuit and the piezoelectric vibrator.

3. (Twice Amended) An ultrasonic motor, comprising: a movable member disposed to undergo movement in response to a drive force; a substrate having a conductor pattern for conveying a drive signal from a drive circuit; a piezoelectric

vibrator provided on the substrate for undergoing oscillating movement in response to the drive signal so as to contact the movable member and generate the drive force to drive the movable member; and a support member provided on the substrate for mechanically supporting the piezoelectric vibrator on the substrate and transmitting the drive signal from the conductor pattern to electrodes of the piezoelectric vibrator so that no conductor wires extend from the substrate to connect the drive circuit and the piezoelectric vibrator, [An ultrasonic motor according to claim 1; wherein] the support member [has] having a constriction portion that is thinner than a connection portion connected to the piezoelectric vibrator.

5. (Twice Amended) An ultrasonic motor, comprising: a movable member disposed to undergo movement in response to a drive force; a substrate having a conductor pattern for conveying a drive signal from a drive circuit; a piezoelectric vibrator provided in a recess provided on the substrate for receiving the piezoelectric vibrator, the piezoelectric vibrator for undergoing oscillating movement in response to the drive signal so as to contact the movable member and generate the drive force to drive the movable member; and a support member provided on the substrate for mechanically supporting the piezoelectric vibrator on the substrate and transmitting the drive signal from the conductor pattern to

electrodes of the piezoelectric vibrator so that no conductor wires extend from the substrate to connect the drive circuit and the piezoelectric vibrator [An ultrasonic motor according to claim 4] ; wherein the substrate has a recess portion for receiving the piezoelectric vibrator.

22. (Amended) An ultrasonic motor, comprising: a movable member disposed to undergo movement in response to a drive force; a substrate having a conductor pattern for conveying a drive signal from a drive circuit; a piezoelectric vibrator provided on the substrate for undergoing oscillating movement in response to the drive signal so as to contact the movable member and generate the drive force to drive the movable member; and a support member provided on the substrate for mechanically supporting the piezoelectric vibrator on the substrate and transmitting the drive signal from the conductor pattern to electrodes of the piezoelectric vibrator so that no conductor wires extend from the substrate to connect the drive circuit and the piezoelectric vibrator; [An ultrasonic motor according to claim 1;] wherein the piezoelectric vibrator is a laminated structure comprising one or more piezoelectric elements polarized to undergo expansion-and-contraction vibration in response to the drive signal and one or more piezoelectric elements polarized to undergo flexural vibration in response to the drive signal so that a side face of the

piezoelectric vibrator adjacent to the movable member undergoes elliptical movement in response to the drive signal to drive the movable member.